

Date: 2003-07-31

Engineering Change Order – Class I

ORIENTATION OF BEAM SCREENS IN THE CRYOMAGNETS OF THE LSS

Brief description of the proposed change(s) :

A beam-screen must be installed in every cold vacuum chamber of the ring. One of the consequences of this decision is related to the geometrical aperture specification of the ring. In many elements, the available space in the cold bore implies to install the beam-screen in a non-standard orientation, i.e. they must be rotated by 90 degrees with respect to the standard arc case. This is related to either the aspect ratio of the beam (non crossing insertions, or matching sections in crossing insertions) or to the beam-beam crossing scheme in the experimental insertions. These changes follow MARIC and LCC decisions.

Equipment concerned : LQN, LQR, LQRL, LQT, LQY, LUU, LUD, LVI, VSS, VST	Drawings concerned : LHCLVIGG0002 (Q1/Q2) LHCLVIGG0001 (Q2/Q3) LHCLVIGK0001 (Q3/DFBX) LHCLVIEJ0001 (Q4/D2) LHCLVIEJ0002 (Q5/D4) LHCVST__0039 (CWT CB50)	Documents concerned : Beam Vacuum Interconnects in the Dispersion Suppressors and LSS of the LHC, LHC- LVI-ES-0003 rev 1.0 EDMS: 350950
PE in charge of the item : J. Knaster AT/VAC, V. Parma AT/CRI	PE in charge of parent item in PBS : P. Strubin AT/VAC	
Decision of the Project Engineer : <input type="checkbox"/> Rejected. <input type="checkbox"/> Accepted by Project Engineer, no impact on other items. <i>Actions identified by Project Engineer</i> <input checked="" type="checkbox"/> Accepted by Project Engineer, but impact on other items. <i>Comments from other Project Engineers required</i> <i>Final decision & actions by Project Management</i>	Decision of the PLO for Class I changes : <input type="checkbox"/> Not requested. <input type="checkbox"/> Rejected. <input checked="" type="checkbox"/> Accepted by the Project Leader Office. <i>Actions identified by Project Leader Office</i>	
Date of Approval : 2003-07-31	Date of Approval : 2003-07-31	

Actions to be undertaken :

Modify the drawing concerned to reflect the changes described in this ECO.
The design of the interconnects and the routing of the cooling capillaries in the SSS must be modified accordingly.
The extra cost if any will be taken from the AT group budget.

Date of Completion : 2003-07-31

Visa of QA Officer :

Note : when approved, an **Engineering Change Request** becomes an **Engineering Change Order/Notification**.

1. DETAILED DESCRIPTION

by Jean Bernard Jeanneret

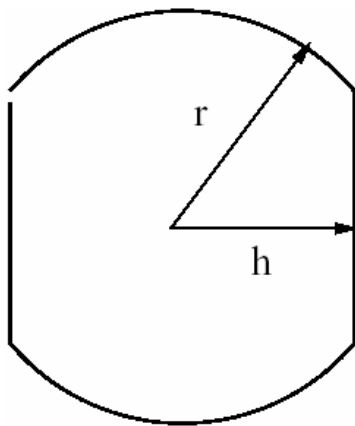
All the originally foreseen beam screens were oriented according to Fig 1B (V-type orientation). After a decision was made to install a beam-screen in every cold section [1], geometrical aperture studies have shown that another orientation was mandatory in many magnets in order to satisfy the aperture specification [2,3,4,5]. The final result of this analysis was reported in the form of a table, which was first published in a Functional Specification [6]. This table is copied here as Table 1.

Table 1 : Cold bore and beam-screen definition of the cryo-elements. The size of the beam-screens for a given cold-bore can be found in Table 2 of [6]. Here only the orientation is given. 'VH' means a V-type orientation for beam 1 and a H-type for beam 2. See Figure 1 for the definition of H and V-types.

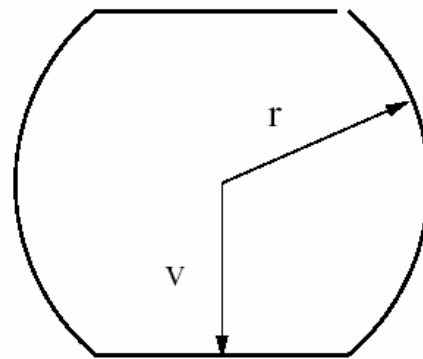
Cold Bore		Interaction Region							
Operating Temp. (K)	Nominal ID/OD (mm)	1	2	3	4	5	6	7	8
4.5	50/53 [#] (replaces 46/49)	Q6L VH Q5L HV Q5R VH Q6R HV	Q6L HV Q5R HV Q6R VH	Q6L VH Q6R HV		Q6L VH Q5L HV Q5R VH Q6R HV		Q6L VH Q6R HV	Q6L HV Q5L VH Q6R VH
1.9	50/53	Q7 VV SM ^{&}	Q7 VV SM ^{&}	Q7 VV SM ^{&}	Q7 VV SM ^{&}	Q7 VV SM ^{&}	SM ^{&}	Q7 VV SM ^{&}	Q7 VV SM ^{&}
1.9	53/57 [i]	Q1 H	Q1 H			Q1 V			Q1 V
4.5	62.98/66.7 [#] (replaces 60/64)	Q4 VV	Q5L HH Q4 HH		Q6L HV Q5L VH Q5R HV Q6R VH	Q4 VV	Q5L VH Q4L HV Q4R VH Q5R HV		Q5R HH Q4 HH
1.9	62.98 [%] /66.7	Q2 H Q3 H	Q2 H Q3 H			Q2 V Q3 V			Q2 V Q3 V
4.5	69.08/73	D2 VV	D2 HH		D4L VH D3L VH D3R VH D4R HV	D2 VV			D2 HH
1.9	74/78	DFBX	D1 V DFBX			DFBX			D1 V DFBX

[#]) Increased cold bore diameter as recommended by LCC. Cooling efficiency with reduced gap to be confirmed by July 2003 [ii].

[&]) DFBA shuffling module.



A) left: a H-type orientation,



B) a V-type one (the arc type orientation)

Figure 1. The definition of orientation of the beam-screen.

2. REASONS FOR CHANGE

By Jean Bernard Jeanneret

It was initially considered that the presence of a beam-screen is mandatory only in high-field cold dipoles in order to overcome the high dynamic pressure induced by the presence of synchrotron radiation. But more recently, it was understood that even in the absence of substantial production of synchrotron radiation, pressure instabilities are unavoidable in a cold vacuum chamber made of a bare cold bore. It was therefore decided at a MARIC meeting to install a temperature-regulated beam-screen in all the cold sections of the rings [1]. All the consequences were evaluated in 2002, in particular w.r.t. the geometrical aperture. The installation of a beam-screen with the standard orientation (i.e. a circular shape with flat sections in its upper and lower part) was limiting the aperture well below the specified equivalent primary aperture $n_1=7.0$ [2,3,4,5]. Other decisions were made, which are not further discussed here. In particular, in some cases a beam-screen of larger size will be used, and one new dimension will be used in the Q1 triplet quadrupole of the experimental insertions. Two beam-screen dimensions will be obsolete and not be produced. This is described in detail in a Functional Specification [6].

3. IMPACT ON COST, SCHEDULE & PERFORMANCE

by Juan Knaster Refolio, Vittorio Parma

The vertical and horizontal orientations of installed beam screens in the cryo-magnets of the matching sections and inner triplets of the LSS imply a more complicated study for the beam line interconnects than originally estimated. A direct extrapolation from the arc design is not possible. Integration of the beam interconnects with the adjacent lines and with the cold warm transitions need to be re-studied. Around 20 extra layout drawings will be needed and a number of extra individual components will have to be designed. The estimated extra number of design hours will be around 1200 with an extra cost of ~60 kCHF. A non-negligible amount of CERN staff time will also be needed. In principle the overall schedule will not be affected, but the time available for overcoming unforeseen problems will be reduced. Some economy will be made with less beam screen sizes to be produced (2-1=1).

The performance will not be affected, except for the inner triplets of the experiment (slightly larger β^* and a subsequent slightly smaller luminosity ($<10\%$)). This was discussed and endorsed by the LCC [2,3] and was presented to the experimental physics community, in particular at the LEMIC [2], with no negative reactions.

4. IMPACT ON OTHER ITEMS

by Jean Bernard Jeanneret

In addition to non-standard orientation of a beam-screen, several other parameters are affected. The inter-beam beam distance of some dog-leg dipoles was changed, see [7]. The cold bore of the D4 dipole in IR4 will be curved longitudinally in order to better follow the beam trajectory. Finally, the plane of the beam-beam crossing scheme will be fixed in IR1 and IR5. These changes are not discussed in this document, but were discussed and endorsed by the LCC. Locking the crossing planes in IR1 and IR5 implies no hardware change.

The impact discussed here is related to the cryogenic system. The main issue is a new routing of the extremity of the cooling capillaries of the beam screen. With the V-type orientation, the capillary is simply curved by 90 degrees in the horizontal plane, in order to be connected to the helium network. For the new H-type beam screen, different solutions may be applied depending on the specific cases [8].

5. CHANGE CLASS

by Paul Cruikshank

Change class I

6. COMMENTS

by Jean Philippe Tock

L'espace disponible pour réaliser les soudures dans les interconnexions doit être pris en compte. Les interconnexions des inner triplets (y compris les lignes faisceaux et refroidissement des écrans de faisceaux ?) sont de la responsabilité de la collaboration américaine.

by Franck Lutton

CNRS comments: The new design of the routing of the cooling capillaries shall take into account the existing design of the qqs tubing and the end caps: shape of the vertical thermal shield for instance. Please, specify if the rotation of the c.c is clockwise/anti-clockwise.

by Theodor Tortschanoff

The change of orientation modifies the position of any welding line along the screen. This will change the multipole content created by the welds. Although this contribution is small if the permeability is low, this should be checked.

7. COMMENTS (IF REQUIRED)

by other Project Engineers

8. COMMENTS (IF ANY)

by PLO Appropriate Committees

9. REFERENCES

1. MARIC Meeting 47-2002, 8.05.2002
2. LCC Meeting 21, 27.3.2002 and LEMIC Meeting 56, 3.12.2002.
3. LCC Meeting 27, 7.07.2002
4. LCC Meeting 29, 25.09.2002
5. LCC Meeting 33, 20.11.2002
6. V. Baglin, I. Collins and N. Kos, Beam screens for the LHC long straight sections, Functional Specification, LHC-VSS-ES-0002 rev 1.0, edms doc 332961, 10.04.2003.
7. ECR LHC-LBR-EC-0002, February 2003.
8. D. Duarte and Y. Patenotre, Inner Triplet Interconnects: Possible solutions for interconnects between beam screens installed vertically, Vac. Tech. Note TN-03-08, EDMS:383579.

[ⁱ] LCC 27, 7 July 2002.
[ⁱⁱ] LCC 33, 20 November 2002.